Title: Late blight management in home and community gardens: benefits transcend Community/Ag boundaries

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Abstract: Late blight is a serious plant disease that affects both gardeners and farmers. Because infected plants produce huge quantities of spores that spread the disease, accurate disease identification and appropriate response are important for everyone in the community growing tomatoes or potatoes. We engaged Cornell Cooperative Extension Master Gardener Volunteer program coordinators to plan and present a series of five workshops for Master Gardener Volunteers across the state. We updated information on disease resistant tomatoes and potatoes on the Vegetable Varieties for Gardeners web site, created resources for Master Gardener Volunteers to use to engage and educate home gardeners about late blight, and have surveyed greenhouse growers on their information needs around growing late blight resistant tomato varieties for sale to gardeners. As a result, Master Gardener Volunteers increased their knowledge of plant disease identification and management, and their outreach activities to home gardeners on late blight management. We also have a list of needs for future outreach to greenhouse growers.

Background and Justification: Late blight is a devastating disease of potato and tomato that is unique in its status as a "community disease," in that the actions (or lack of actions) of individuals affect the larger community of tomato and potato growers. At present in the U.S., late blight only overwinters in living tissue such as potato tubers, or infected tomato plants that survive the winter in a greenhouse. Both commercial farmers and gardeners have the potential to unknowingly maintain the pathogen, which can then spread to anyone growing potato or tomato within a potentially 30 mile radius. In 2009, large numbers of gardeners experienced late blight for the first time when infected tomato transplants were sold widely throughout the Northeast, and rainy conditions contributed to fostering the "perfect storm" of late blight. Since 2009, late blight has occurred in the Northeast at levels substantially higher than it had in previous years (McGrath, unpublished data) with the same isolate dominating the pathogen population for the past three years. This suggests late blight is overwintering in potato tubers in our region. While potato seed planted by commercial growers is one potential inoculum source, gardeners who are not aware of the pathogen life cycle may also be inadvertently saving and planting infected tubers or not destroying volunteer or cull potatoes. Extension educators and faculty throughout the Northeast have observed that the initial reports of late blight in their area are increasingly from gardens (McGrath, personal communication). Vegetable gardening has increased in the past several years (http://www.mnn.com/your-home/organic-farming-gardening/stories/infographic-home-gardening-in-the-us) partly because of the economic

downturn and partly because of increased interest in healthy lifestyles. Both gardeners and farmers will benefit if all understand the biology of the pathogen, recognize symptoms, plant resistant varieties, and take measures to minimize inoculum sources. Planting resistant varieties and reducing inoculum sources will slow epidemic development and spread, help prevent crop losses, and reduce the number of fungicide applications needed to protect crops.

Many gardeners use tomato transplants rather than starting their own seed. One complaint is that late blight resistant varieties are not available as transplants at local garden centers. In a previous project, we learned that garden centers growing transplants do not think that disease resistance is a primary characteristic for choice of variety by customers. However, late blight has become so well known by home gardeners and a source of questions for garden centers, that late blight resistant tomato transplants may be a marketable option of interest to garden centers.

Objectives:

1) Harmonize information and increase linkages between late blight information developed for farmers and that developed for gardeners
2) Create late blight resources and activities that will increase Cornell Cooperative Extension (CCE) Master Gardener Volunteers' skills, confidence, and level of outreach
3) Create late blight resources for garden centers/greenhouses selling tomato transplants, and their customers, to encourage the use of resistant varieties
4) Evaluation

Procedures:

We engaged Cornell Cooperative Extension Master Gardener Volunteer program coordinators in a series of three online focus groups to gather their input on Master Gardener Volunteer (MGV) needs for late blight information, and strategies to engage them in learning more about late blight and tomato foliar diseases in general, with a goal of increasing their confidence in undertaking outreach activities about late blight and other tomato foliar diseases with the public. We presented a series of workshops across the state on plant disease biology and identification, focusing on late blight identification and management, attended by 158 MGV and educators from 36 counties (agenda in Appendix 1). Workshop participants were tasked with sharing what they had learned with fellow MGV and home gardeners in their county. Two of the PowerPoint presentations from the workshops were narrated and made available to MGVs for use educating their fellow MGVs and the community.

We developed a survey of MGV on their knowledge of late blight to establish a baseline. Workshop attendees were asked to take the survey again after each workshop, and the entire group of MGV was surveyed again at the end of the 2015 growing season.

We updated late blight resistance information on the Vegetable Varieties for Gardeners (VVfG) (http://vegvariety.cce.cornell.edu/main/login.php) web site, harmonizing it with information developed for commercial vegetable farmers, and added four additional

resistant varieties. We have baseline data for the number of reviews for varieties already listed, and will track reviews of these and the additional four varieties.

We provided workshop participants with seeds for four different tomato varieties that are resistant to late blight. MGVs in some counties grew seedlings to sell or provide to home gardeners during outreach events or plant sales. Others included them in demonstration or community gardens.

We developed a survey for greenhouse growers to determine how aware they are of late blight resistant tomato varieties, how many are growing late blight resistant tomato varieties for sale to home gardeners, and their needs for point of purchase information on late blight and late blight resistant tomatoes. The survey was completed by 59 growers at Greenhouse/Bedding Plant Schools in 2015.

At a presentation entitled "Selling knowledge: providing pest management information to your customers" Lamb used clicker technology (81 respondents) to ask the audience the following questions:

Would information on managing late blight encourage customers to come to your shop and buy tomato transplants?

After showing examples of the available materials and resources (list of resistant varieties, infographic, Meg McGrath's late blight management brochure, and the USABlight website), growers were asked:

Would these materials be useful to you?
Yes for retail customers
Yes for wholesale customers
Yes for both retail and wholesale
No

We developed a one page handout/poster to help MGV and home gardeners distinguish between late blight, early blight, and Septoria leaf blight. This idea came from Master Gardener coordinators who participated in the initial webinars.
http://www.nysipm.cornell.edu/vegetables/late_blight/tom_dis_infographic_legal.pdf
and:
http://www.nysipm.cornell.edu/vegetables/late_blight/tom_dis_infographic_14x24.pdf

We created a video on what gardeners should do it they find late blight. It's posted at: https://www.youtube.com/watch?v=j6DaNWHecEE and has been viewed 470 times since June, 2015.

Results and Discussion:
MGV Late blight knowledge survey
Twenty-three of the survey questions were on late blight biology or identification. The entire group averaged 47% correct answers before the workshops and 54% correct

answers at the end of the 2015 growing season (20% increase). The group who attended the workshops averaged 79% correct answers after the workshops (119% increase). While the workshops were very successful at increasing knowledge of late blight identification and biology for those who attended, the diffusion of that knowledge into the general MGV community was less successful, although most counties now have MGVs who can serve as late blight experts.

Bedding plant grower survey

Fifty four percent of survey respondents grew late blight resistant varieties; averaging 23% of their tomato transplant sales. Of those not growing late blight resistant varieties, 53% reported not knowing what varieties are resistant, 11% said there was no demand from customers, and 11% said they couldn't find resistant varieties to sell. In Table 1, late blight resistant varieties are ranked by the percent of growers selling them. In response to an "other" choice included in the list below, growers mentioned a variety that hasn't been trialed at Cornell, Cloudy Day hybrid from Burpee seeds.

Table 1. Percent growers selling each late blight resistant variety

Variety	% Growers Selling
Black Krim	52
Yellow Pear	52
Mr. Stripey	48
Defiant	43
Aunt Ruby's German Green	33
Mountain Magic	33
Jasper	19
Mountain Merit	19
Iron Lady	14
Lemon Drop	14
Prudens Purple	14
Legend	10
Matt's Wild Cherry	10
Red Currant	10
Yellow Currant	5
Black Plum	5

Most growers don't distinguish late blight resistant and susceptible varieties in their sales space, but those who do are using bench signage or a display (38%), with 3% using special labels or information on managing late blight in the garden. Information that growers report customers asking for include: information on how to avoid or control late blight, and which varieties of transplants are resistant to late blight, sprays for late blight, and diagnosis of suspect symptoms. Fifty six percent of growers provide customers with information on late blight, including a description of the disease and its symptoms (46%), methods of managing it in the home garden (44%), and lists of resistant varieties (15%).

Information that growers indicated they would find useful includes: results of variety trials of late blight resistant varieties (84%), information on seed availability of resistant varieties (50%), how to track where late blight has been found in NY (47%), customer information on managing late blight in the garden (78%), customer information explaining disease resistance (63%), and customer information on late blight resistant varieties (63%).

Clicker survey results

Would information on managing late blight encourage customers to come to your shop and buy tomato transplants?

Yes	55%
No, I don't think so	16%
I don't know	26%

After showing examples of the available materials and resources (list of resistant varieties, infographic, Meg McGrath's late blight management brochure, and the USABlight website), growers were asked:

Would these materials be useful to you?

Yes for retail customers	56%
Yes for wholesale customers	2%
Yes for both retail and wholesale	27%
No	13%

Clearly, there are opportunities for future collaboration between Vegetable IPM and Ornamentals IPM to provide bedding plant growers with additional information on late blight that they can use themselves and that they can provide to their customers to improve their success growing tomatoes.

Vegetable Varieties for Gardeners (VVfG) web site

Only a handful of reviews were entered for the late blight resistant varieties since they were updated for this project. More outreach is needed to urge MGV and gardeners to review these varieties.

Selected outreach activities by CCE Master Gardener Volunteer programs

We provide here a few examples of the outreach efforts of the 36 CCE MGV county programs that now have local volunteers who can serve as late blight experts.

CCE Erie county volunteers recruited fellow volunteers and commercial nursery and vegetable growers to help start the nearly 500 tomato seeds from the 4 different varieties we shared at the workshops. The transplants we distributed by volunteers as well as through commercial avenues to provided an opportunity for the nurseries to educate their customers on the availability of disease resistant plants. Further volunteers offer a late blight workshop to 30 participants at the regional spring gardening expo; share the new late blight resources at public events throughout the year including to 250 contacts at

county; and provide over 100 copies of the list of late blight resistant varieties and other project factsheets during the growing season via the garden at the extension office.

In the spring CCE Seneca county Master Gardener Volunteers hosted a workshop for 24 people around how to tell if you have late blight and how to try to prevent late blight. They also planted nine of the varieties deemed "late blight resistant" in their public demonstration gardens and at the end of the season held an open house attended by 21 people to report on how the plants fared and how the fruit tasted. People were surprised at how tasty many of the late blight resistant varieties were. Many said they would consider planting some of the late blight resistant varieties in their own gardens.

CCE Wayne county Master Gardener Volunteers began a Late Blight community education outreach initiative that included a Tomato Growing/LB workshop for home and community garden managers and distribution of late blight alerts to 1500 enewletter clients and to consumers who contacted the gardening hotline. In addition, volunteers grew and distributed Late Blight resistant tomato plants to local community/school gardens, and provided support at the gardens throughout the year to troubleshoot problems and address questions. They followed up with surveys to determine change in management practices and impacts on tomato health. Through these efforts 395 residents received information in person that could help them make informed decisions about Late Blight and growing healthy tomatoes with 103 people responding to surveys saying that they would be or already did change management practices due to the information provided. Moreover, 78 participants at 13 community/school gardens had an opportunity to grow late blight resistant tomatoes and an additional 298 youth had opportunity to eat tomatoes from these gardens.

Samples of Resources Developed

Two narrated PowerPoint presentations accessible by MGVs:

- What is blight?
- Why is late blight a big deal?

Got the blight? Which one? infographic:
Legal size:
http://www.nysipm.cornell.edu/vegetables/late_blight/tom_dis_infographic_legal.pdf
14 x 24":
http://www.nysipm.cornell.edu/vegetables/late_blight/tom_dis_infographic_14x24.pdf

Video: What to do if you find late blight in your garden
https://youtu.be/j6DaNWHecEE

Appendix 1.

Cornell Garden-Based Learning Regional Training for CCE Educators and Master Gardener Volunteers

In this training we spend much time understanding tomato diseases, specifically late blight. We believe deep understanding and skill in this one area will be empowering for participants and most valuable in addressing an important issue for gardeners and the vegetable growing industry. Moreover, we hope it is a foundation for better understanding plants and plant diseases in general.

The Blight: What To Know and Do

Welcome (15 minutes)

What is blight? What else could it be? (30 minutes)
Water molds, fungi, bacterial, viral, insect and abiotic factors including management
Why late blight is a big deal for growers and gardeners (15 minutes)
Key steps in plant diagnosis (15 minutes)
Walk-through for potato & tomato plant diagnosis (groups – 25 minutes)
Scenario packets with photos and/or situation descriptions
Teams provide diagnosis summary (15 minutes)
Walk-through diagnosis checklist/decision tree and comparison factsheets among septoria, early blight and late blight (5 minutes)
Examine late blight tissue in tomatoes and tubers using plant material, microscope, pictures and videos (15 minutes)

Brown Bag Lunch *(30 minutes)*

Examine late blight tissue in tomatoes and tubers using plant material, microscope, pictures and videos (15 minutes)
What is most important at different stages in the season? (15 minutes)
Draft "take action" messages for gardeners in cross county teams (45 minutes)

- Prevention
- Scout/monitoring
- Tracking
- Diagnosis
- Slow the disease
- Surrender to the disease
- Overwinter

Revisit potato & tomato plant diagnosis to add messages (groups - 5 minutes)
Late blight resistant varieties including seed starting details (10 minutes)
Share ideas on community outreach (25 minutes)
Wrap up (5 minutes)

The counties who attended the regional this one-day workshop:

1. Albany
2. Allegany
3. Broome
4. Chautauqua
5. Columbia
6. Cortland
7. Dutchess
8. Erie
9. Essex
10. Genesee
11. Greene
12. Herkimer
13. Jefferson
14. Livingston
15. Oneida
16. Onondaga
17. Ontario
18. Orange
19. Otsego
20. Putnam
21. Rensselaer
22. Rockland
23. Saratoga
24. Schenectady
25. Schoharie
26. Seneca
27. St. Lawrence
28. Sullivan
29. Tioga
30. Tompkins
31. Ulster
32. Warren
33. Wayne
34. Westchester
35. Wyoming
36. Yates